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SCHOOL OF ELECTRICAL ENGINEERING

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BIBLIOGRAPHY OF EXTRATERRESTRIAL RADIO NOISE

SUPPLEMENT FOR 1950

by

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CONTENTS

	Page
INTRODUCTION	1
SECTION A. RADIATION FROM THE SUN	
Part 1. Observations	5
Part 2. Theories and Interpretations	15
SECTION B. GENERAL GALACTIC RADIATION	
Part 1. Observations	25
Part 2. Theories and Interpretations	29
SECTION C. RADIATION FROM "DISCRETE SOURCES"	
Part 1. Observations	33
Part 2. Theories and Interpretations	39
SECTION D. RADIATION FROM THE MOON	43
SECTION M. MISCELLANEOUS	47
SECTION R. REVIEWS	53
AUTHOR INDEX	59

INTRODUCTION

In the period of time since the publication of the "Bibliography of Extraterrestrial Radio Noise,"* research in this field of investigation has been rapidly progressing. The present report contains a record of the pertinent publications which appeared during the year 1950.

In arrangement and scope of subject matter, as well as in other respects, this "Supplement for 1950" is similar to the original "Bibliography of Extraterrestrial Radio Noise." Since a complete description of the latter is given in its Introduction, only the more important features applicable to the present supplement will be mentioned here.

As before, the references are grouped by subject matter into separate sections whose titles are given in the Table of Contents. Within each section the arrangement is alphabetical by author, or by title if no author is given. Each reference is assigned a composite number which consists of three parts, e.g., A2-50-07. The first part (A2) indicates the section and subsection (if any) in which the reference is listed, the second part (50) gives the year of publication, and the third part (07) is a serial number determined by the alphabetical arrangement. Each reference appears in one section only; at the end of every other section to which its content is appropriate, it is referred to by number.

Occasional cross-references are made by number. A number whose middle unit is 49 or less indicates a reference which does not appear in the present supplement but may be found in the original bibliography.

All references are accompanied either by brief abstracts, or, especially in the case of reviews, by statements indicating their scope. Each previously published abstract here reproduced by quotation, condensation, or adaptation is acknowledged by a key letter designating the publication in which it appears, together with the signature (if any) accompanying it in that publication. The interpretation of

*Issued on August 15, 1950, as part of the Report of Commission V to the IXth General Assembly of the International Scientific Radio Union, and as Radio Astronomy Report No. 11 of the School of Electrical Engineering, Cornell University.

the key letters follows:

(A) from author's abstract or summary
(P) from Physics Abstracts (Section A of Science Abstracts)
(W) from Wireless Engineer.

For example, the acknowledgement (P:B.F.Kraus) accompanies an abstract taken primarily from Physics Abstracts where it appears over the signature B. F. Kraus. Abstracts signed (M.S.C.) were prepared by the writer, Martha Stahr Carpenter. Several abstracts have been compiled from two sources, both of which are acknowledged in order of importance.

All references have been checked for accuracy against original papers, reprints, or photostats. The general procedure followed in the statement of references is to specify consecutively the author, title of paper, name of journal, volume number, pages, and date. The issue number is given only if no month of publication appears on the issue in question. Other necessary deviations from the generally adopted form of statement are self-explanatory. In keeping with accepted bibliographical procedure, square brackets have been used to designate information supplied by the bibliographer. The titles of certain periodicals have been abbreviated as follows:

Aust. J. Sci. Res.	Australian Journal of Scientific Research
B. A. N.	Bulletin of the Astronomical Institutes of the Netherlands
Comptes Rendus	Comptes Rendus des Séances de l'Académie des Sciences
Contrib. I. A. P.	Centre National de la Recherche Scientifique. Contributions de l'Institut d'Astrophysique de Paris
J. B. A. A.	Journal of the British Astronomical Association
J. Geophys. Res.	Journal of Geophysical Research
J R. A. S. C.	Journal of the Royal Astronomical Society of Canada
M. N.	Monthly Notices of the Royal Astronomical Society
Phil. Mag.	Philosophical Magazine
Phys. Rev.	Physical Review, Series II
Proc. I. E. E.	Proceedings of the Institution of Electrical Engineers
Proc. I. R. E.	Proceedings of the Institute of Radio Engineers
Proc. Phys. Soc.	Proceedings of the Physical Society of London
Proc. Roy. Soc.	Proceedings of the Royal Society of London
Pub. U. S. Naval Obs.	Publications of the United States Naval Observatory, Second Series.

Each of Sections A1, B1, and C1 contains a "Supplementary Summary of Observed Wavelengths." The wavelengths on which observations of the appropriate type of extraterrestrial radio noise were reported during the year 1950 are given in each case. The organizations performing the observations and the numbers of the corresponding references in this supplement are specified. Some of the necessary information has been supplied by the bibliographer. The shaded bands in the chart on page 6 represent regions of the spectrum in which continuous "sweeps" have been made.

In the author index which begins on page 59, the references are designated by number. A number placed in parentheses indicates a secondary contribution, i.e., an article reporting a contribution of a given author but not listed in his name. The reports of meetings of the Royal Astronomical Society, for example, are indexed in this way under each of the participants.

The continued helpfulness of colleagues, librarians, and friends, and especially of those authors who have sent reprints of their papers, is gratefully acknowledged. The preparation of this report was facilitated by the use of material from the personal libraries of Professors R. W. Shaw and L. P. Smith.

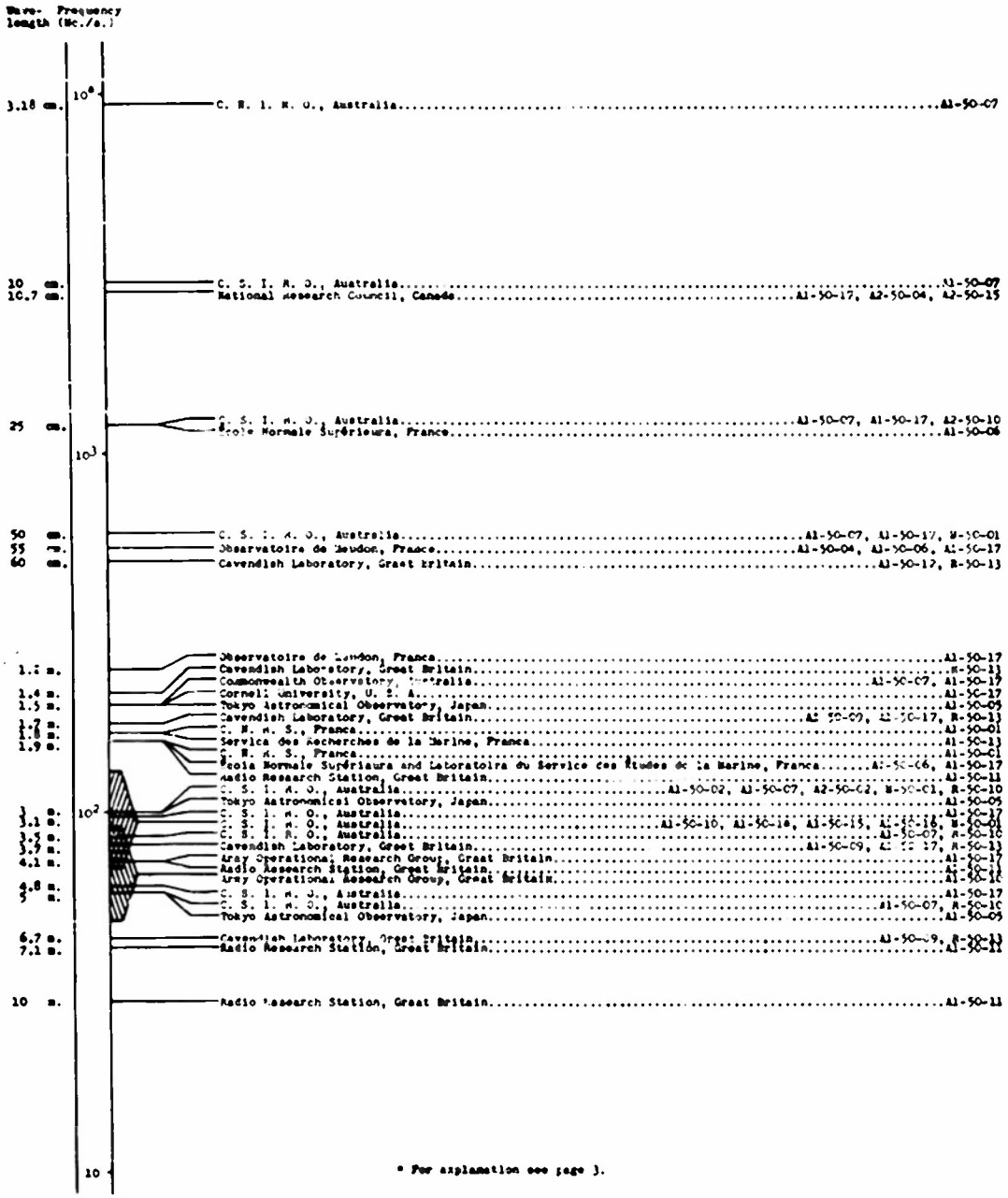
SECTION A

RADIATION FROM THE SUN

Part 1. Observations

RADIATION FROM THE SUN

SUPPLEMENTARY SUMMARY OF OBSERVED WAVELENGTHS*



* For explanation see page 3.

A1. RADIATION FROM THE SUN: Observations

A1-50-01 Blum, Émile-Jacques, and Denisse, Jean-François. "Comparaison des Rayonnements Radioélectriques Reçus du Soleil sur Deux Fréquences Voisines," Comptes Rendus, 231, 1214-1216 (Nov. 27, 1950).

Solar radiation was recorded simultaneously on frequencies of 156 and 164 Mc./s. during a particularly inactive solar period from October 10, to November 10, 1950. The receivers had bandwidths of 2 Mc./s. and were fed by a common antenna whose pass band extended from 155 to 175 Mc./s. Except for isolated bursts, whose times of occurrence and general characteristics were the same on both frequencies, both signals remained for extended periods within 20 percent of the mean level of 4 to 5 x 10^{-22} watt $m.^{-2}$ $(c./s.)^{-1}$. Several mild radio storms were recorded; these were composed of successions of bursts which, unlike the isolated bursts, were entirely dissimilar on the two frequencies. Some radio storms became much weaker on 156 Mc./s. than on 164 Mc./s., as if the source of the disturbance were temporarily obscured by a cloud which absorbed the radiation of the lower frequency. (M.S.C.)

A1-50-02 Bracewell, R. N. "An Instrumental Development in Radio Astronomy," Observatory, 70, 185-186 (Oct., 1950).

A new instrument which automatically determines the place of origin and polarization of solar bursts occurring on a wavelength of 3 meters has been developed by R. Payne-Scott and A. G. Little. The required cycle of operations involves the use of three antennas and is completed in one second; the instrument is therefore able to follow the movement of a burst through the sun's atmosphere. A diagram showing the motion of an outburst of noise which accompanied a flare on February 17, 1950, is given. In this case the source of noise moved from near the flare to a point beyond the limb and high in the corona. (M.S.C.)

A1-50-03 British Astronomical Association. "Report of the Ordinary General Meeting of the Association [Mar. 29, 1950]," J. B. A. A., 60, 153-162 (May, 1950). [Material pertaining to extraterrestrial radio noise on pages 157-158.]

Speaking on recent sunspots, H. W. Newton described phenomena associated with the giant sunspot group of February, 1950. Intense flare activity and also strong bursts of solar radiation on wavelengths of about 5 meters occurred on February 17 and 20. Newton concluded his remarks by showing and describing contour diagrams of the spectra of bursts as recorded by Wild and McCready over the range of frequencies from 70 to 130 Mc./s. (M.S.C.)

A1. RADIATION FROM THE SUN: Observations

A1-50-04 Bureau, Robert, and Dauvillier, Alexandre. "L'Éruption Chromosphérique du 19 Novembre 1949 et ses Conséquences Géophysiques," Annales de Géophysique, 6, 77-103 (Apr.-June, 1950).

A striking correlation between abnormally intense cosmic radiation and ionospheric phenomena occurred at the time of a chromospheric flare on November 19, 1949. The observational evidence is described in detail and discussed. The correlation is particularly remarkable because only three such occurrences have been reported since 1942. The flare was also accompanied by a geomagnetic crochet and by an intense burst of solar radio emission, and was followed on the nights of November 19 and 20 by an aurora. M. Laffineur's record of the solar radiation on a wavelength of 55 centimeters is reproduced. (M.S.C.)

A1-50-05 Hatanaka, T., Suzuki, S., and Moriyama, F. "Solar Radio Noise," Bulletin of Solar Phenomena (Tokyo Astronomical Observatory), 2, 12-15 (Jan.-Mar., 1950), 27-30 (Apr.-June, 1950), and under the title, "Solar Radio Emission," 43-45 (July-Sept., 1950) and 59-61 (Oct.-Dec., 1950). (A. "Steady Flux and Burst Character Figure"; B. "Outburst.")

Information concerning the solar emission observed on a frequency of 200 Mc./s. during the year 1950, is tabulated. The data include daily values of the steady flux, hourly indices relating to the number of bursts per hour, and times of occurrence, durations, and measurements of flux of outbursts. (M.S.C.)

A1-50-06 Laffineur, Marius, Michard, Raymond, Servajean, Roger, and Steinberg, Jean-Louis. "Observations Radioélectriques de l'Éclipse de Soleil du 28 Avril 1949," Annales d'Astrophysique, 13, 337-342 (July-Sept., 1950), reprinted as Contrib. I. A. P. B, No. 53.

The solar radiation on wavelengths of 25, 54.5, and 190 centimeters was observed during the partial solar eclipse of April 28, 1949. The results on 190 centimeters were excluded from the subsequent discussion because the sun showed at this wavelength a strong intrinsic variability which is difficult to distinguish from the apparent variability caused by the eclipse. For the shorter wavelengths, a common curve showing the intensity as a function of time was constructed. Its principal features are: (1) agreement in the times of the "contacts" with those of the visual eclipse, (2) maximum diminution of 20 percent, in contrast to a maximum decrease of 26 percent in the exposed area of the sun's visible disk, and (3) a marked dissymmetry. The observations can best be accounted for on the assumption that about half of the radiation comes from a uniformly bright disk, and the remainder from a source whose distribution over the disk is the same as that of the "plages faculaires," these being weighted in importance according to the strength of their emission in H . (M.S.C.)

A1. RADIATION FROM THE SUN: Observations

A1-50-07 Minnett, H. C., and Labrum, N. R. "Solar Radiation at a Wavelength of 3.18 Centimetres." Aust. J. Sci. Res. A, 3, 60-71 (Mar., 1950).

Solar radiation on a wavelength of 3.18 centimeters was measured over a period of three months. The received intensity was found to vary from day to day and the changes are shown to be closely associated with sunspots. The equivalent black-body temperature of the sun over this period, in the absence of sunspots, was 19,300 °K, with a probable error of ±7 percent. The temperature increased by 8 °K per unit increase of sunspot area. (One unit equals 10^{-5} times the area of the sun's visible disk.) This increase is much less than that at longer microwavelengths. Sudden increases of radiation at 3.18 centimeters, caused by disturbed conditions in the sun, were found to be rare. A number of bursts were observed and a comparison is made with records of longer-wave solar radiation and other phenomena of solar origin. Observations were made during the solar eclipse of November 1, 1948, and the results are consistent with either of two simple brightness distributions on the sun's disk. In the first of these, 74 percent of the energy is emitted uniformly by the sun's visible disk and the remaining 26 percent by a bright ring around the circumference; in the second, the whole of the radiation comes from a uniform disk of diameter 1.1 times that of the visible sun. (A)

A1-50-08 Newton, H. W. "Solar Flares Observed in Monochromatic Light" (Section of "Solar Activity" by H. W. Newton and A. K. Das). M. N., 110, No. 2, 169-170 (1950).

Data concerning six notable flares observed in Greenwich during the year 1949 are summarized. Bursts of solar radio-frequency radiation accompanied those on February 1, August 5, September 18, and November 19. The frequency of major bursts on wavelengths of about 4 meters indicated the following very active solar periods: January 30-February 7, March 11-16, March 20-26, April 9-15, May 9-12, June 4-7, June 14-17, June 26-30, July 9, July 14-15, July 30-August 7, August 22-29, September 8-18, September 24, October 1-13, and November 19-29. (M.S.C.)

A1-50-09 Ovenden, Michael W. "An Eruptive Prominence and Associated Solar Limb Flare 1948 October 9," J. B. A. A., 60, 51-55 and discussion under different title on pages 49-50, (Jan., 1950).

The progress and development of an eruptive prominence, and the evidence leading to its identification as the surge associated with a limb flare, are summarized. An accompanying fade-out of short-wave radio reception occurred, but concurrent observations of solar radio noise on 45, 80, and 175 Mc./s. indicated no unusual

effects. Characteristics of four previously observed limb flares are briefly reviewed. (M.S.C.)

A1-50-10 Royal Astronomical Society. "Meeting of the Royal Astronomical Society [Mar. 10, 1950]," Observatory, 70, 55-62 (Apr., 1950). [Material pertaining to extraterrestrial radio noise on pages 56-57.]

A letter by Bracewell, outlining observations of solar noise made by Wild and McCready, was summarized at this meeting by H. W. Newton. "Dynamic spectra" of bursts were presented in the form of colored diagrams in which abscissas represent frequencies ranging from 70 to 130 Mc./s., ordinates represent time in seconds, and colors represent intensities. A systematic drift of maximum intensity with time from higher to lower frequencies was indicated. J. S. Hey, in describing observations of a similar nature for frequencies from 50 to 90 Mc./s., stated that the variation of intensity with time differs for different frequencies, and that the spectra of continuous emissions from sunspots are much steadier than those of the bursts associated with flares. (M.S.C.)

A1-50-11 Smith-Rose, R. L. "Solar Noise and Ionospheric Fading," Nature, 165, 37-38 (Jan. 7, 1950).

Observations of solar noise on frequencies of 30, 42, 73, and 155 Mc./s. were compared with simultaneous recordings of ionospheric transmission on 18.89 Mc./s. and 191 Kc./s. A number of examples of the accompaniment of a burst of noise by a fade-out of the high-frequency signal and a marked fluctuation of the low-frequency signal were found. The most outstanding occurred on May 21, 1948, when a low-frequency variation characteristic of interference between the ground and ionospheric waves was observed. This effect is attributed to an increase in ionization density, resulting in a decreasing equivalent height and an increasing effective reflection coefficient of the ionospheric reflecting region. The start of the ionospheric phenomena on this occasion preceded the burst of solar noise by some five minutes. The ionospheric records, together with that of the solar burst on 30 Mc./s., are reproduced. (M.S.C.)

A1-50-12 Stanier, H. M. "Distribution of Radiation from the Undisturbed Sun at a Wave-Length of 60 cm.," Nature, 165, 354-355 (Mar. 4, 1950).

The distribution of radio "brightness" over the undisturbed solar disk was deduced from observations with two antennas spaced at separations up to 365 times the received wavelength of 60 centimeters. Circular symmetry was assumed and contributions from the few sunspots present at the times of observation were subtracted. No evidence for limb-

brightening was detected. The intensity was found to drop from center to limb in the ratio 1:0.66, the region outside the visible disk contributing 30 percent of the total radiation. An equivalent solar temperature of $5.4 \pm 0.5 \times 10^5$ °K was derived. (M.S.C.)

A1-50-13 "Une Très-Violente Perturbation Solaire" (Section of "Notes Extraites d''É. N. S. Physique'"). Revue Scientifique, 88, 45 (Jan.-Mar., 1950).

Astronomers have announced large sunspots. We are giving below the effective temperatures of the sun, measured, on the wavelength of 1.80 meters, at the station of the Service des Recherches de la Marine at Marcoussis (S.-et-O.).

Date	Temperature (in millions of degrees)
8 February 1950	7.5
9 -- --	16.4
10 -- --	13.5
11 -- --	9.3
12 -- --	16.4
13 -- --	50
14 -- --	133
15 -- --	50
16 -- --	70
17 -- --	135 (at 10^h)
	13.5 (at 12^h)
18 -- --	62
19 -- --	33
20 -- --	91

The numbers represent a mean of the observations made during two hours around noon, except for February 17 when we witnessed an exceptionally rapid drop. It appears that it is a question of a very violent disturbance. (Reproduced in full in translation. M.S.C.)

A1-50-14 Wild, J. P. "Observations of the Spectrum of High-Intensity Solar Radiation at Metre Wavelengths. II. Outbursts," Aust. J. Sci. Res. A, 3, 399-408 (Sept., 1950).

Observations of the spectrum of outbursts of solar radiation in the frequency range from 70 to 130 Mc./s. are described. In accordance with Part I (see A1-50-16), an "outburst" is defined as a burst having a particular type of dynamic spectrum, characterized by a drift of spectral features, with time, towards the lower frequencies at a rate of the order of $\frac{1}{4}$ Mc./s. per second. The observed outbursts have a close connection with solar flares and their geophysical accompaniments. The spectra are tentatively interpreted in terms of the motion of a physical agency in the solar atmosphere. The possible identification of the agency with "surge" prominences and the

corpuscular streams that cause a type of terrestrial magnetic storm is discussed. The evidence is quite consistent with the hypothesis that the agency corresponds to the magnetic-storm particles. (A)

A1-50-15 Wild, J. P. "Observations of the Spectrum of High-Intensity Solar Radiation at Metre Wavelengths. III. Isolated Bursts," Aust. J. Sci. Res. A, 3, 541-557 (Dec., 1950).

Observations of the spectrum of "isolated bursts" of solar radiation in the frequency range from 70 to 130 Mc./s. are described. These bursts last for a few seconds and have a bandwidth of the order of tens of megacycles per second. Prior observations indicate that they are not circularly polarized. They occur sporadically, often in small groups; many hours sometimes elapse between successive bursts or groups. Although, in general, their spectra show diverse features, some of them (referred to as "type III" bursts) are of a distinct type characterized by a rapid drift, with time, of the frequency of maximum intensity towards the lower frequencies, at a rate of the order of 20 Mc./s. per second. Characteristics of the spectra of type III bursts are described in detail. The results are discussed and hypotheses of origin examined. It is shown in particular that the frequency drift of type III bursts cannot be attributed to the selective group retardation of waves in the solar atmosphere emanating from a fixed source. The frequency drift may, however, be associated with the rapid motion of a source traveling outwards through the solar atmosphere. (A)

A1-50-16 Wild, J. P., and McCready, L. L. "Observations of the Spectrum of High-Intensity Solar Radiation at Metre Wavelengths. I. The Apparatus and Spectral Types of Solar Burst Observed," Aust. J. Sci. Res. A, 3, 387-398 (Sept., 1950).

An apparatus for recording the dynamic spectrum of high-intensity solar radiation (in particular the sudden bursts) in the frequency range from 70 to 130 Mc./s. is described. The spectra are displayed on a cathode-ray tube at intervals of about one-third of a second. Solar bursts observed with the apparatus were found to have widely different spectra. However, analysis of a number of bursts indicated the common occurrence of three distinct spectral types. These types are described and illustrated by samples. One type, of narrow bandwidth, was exhibited by short-lived bursts that occur in large numbers during periods of high intensity ("noise storms"); these bursts are presumed to be circularly polarized and associated with sunspots. A second type, characterized by a slow drift of spectral features towards the lower frequencies, was exhibited by sporadic outbursts associated with solar flares. Other sporadic bursts had diverse spectra, but some of them conformed to a third spectral type in

which the frequency of maximum intensity drifts rapidly towards the lower frequencies. The result that outbursts seem to exhibit a distinct type of spectrum is considered to provide a possible means of recognizing these phenomena with certainty. (A)

A1-50-17 Woolley, R. v. d. R. "Solar Radio Noise Data." Quarterly Bulletin on Solar Activity (International Astronomical Union), No. 89, 126-130 (Jan.-Mar., 1950); No. 90, 150-154 (Apr.-June, 1950); No. 91, 176-180 (July-Sept., 1950); No. 92, 192-195 (Oct.-Dec., 1950). (1. "Flux"; 2. "Polarisation"; 3. "Variability"; 4. "Outstanding Occurrences.")

The following data on solar radio noise during the year 1950 are tabulated: daily medians of flux in units of 10^{-22} watt $m.^{-2}$ $(c./s.)^{-1}$, daily medians or means of the sense and percentage of polarization, daily indices of variability, and characteristics of outstanding occurrences. The observations were contributed by eight observing stations, operating on a total of thirteen separate frequencies in the range from 62 to 2800 Mc./s. (M.S.C.)

See also: A2-50-02, A2-50-04, A2-50-10, A2-50-15, M-50-01, M-50-03, M-50-04, M-50-05, M-50-08, M-50-09, R-50-10, and R-50-13.

SECTION A

RADIATION FROM THE SUN

Part 2. Theories and Interpretations

A2. RADIATION FROM THE SUN: Theories and Interpretations

A2-50-01 Bailey, V. A. "The Growth of Circularly Polarized Waves in the Sun's Atmosphere and Their Escape into Space," Phys. Rev., 78, 428-443 (May 15, 1950).

The theory (see A2-48-01 and A2-48-02) of plane waves in an ionized medium pervaded by static electric and magnetic fields is shown to predict wave amplification, and consequent electromagnetic noise, in certain frequency bands. It is then developed in detail for the case in which the static fields are both parallel to the direction of wave propagation and the perturbations are transverse to this direction. It is shown that for any given frequency and electron drift velocity there are two trios of such waves, E_1 and E_2 waves, all circularly polarized; the E_1 and E_2 waves are oppositely polarized. It is found that any transverse perturbation temporally prescribed at a given plane can be split up into two such trios which can then be considered independently. Necessary and sufficient conditions are then found under which a growing flux of energy carried by E_1 or E_2 waves can pass normally through the boundary between two different ionized mediums. The theory is applied to show that under simple hypotheses about the drift of electrons in the atmosphere above a large sunspot strong circular waves can arise by growth of random transverse perturbations and can then escape from the sun. The consequences of two such hypotheses are compared with known observations of solar noise and used to interpret them. It is concluded that the general hypothesis that electrons in a sunspot have a drift motion leads to results which are in good agreement with many facts about strong solar noise and which do not disagree with any others. The ultimate intensity which a growing perturbation can attain is also discussed. (A)

A2-50-02 Bailey, V. A., and Landecker, K. "Electro-Magneto-Ionic Waves." Nature, 166, 259-261 (Aug. 12, 1950).

The general theory of plane electromagnetic waves in an ionized medium pervaded by static electric and magnetic fields (see A2-48-03, A2-48-01, and A2-48-02) indicates that there are several frequency bands in which strong electromagnetic noise can be generated by the growth of waves from small random perturbations. The existence of such bands was verified in a series of experiments with discharge tubes having various arrangements of electrodes, and containing helium, hydrogen, nitrogen, argon, or mercury vapor at various pressures. When a uniform magnetic field of more than 100 gauss was applied along the axis of a tube, two or three of the three expected noise bands always appeared; their characteristics are described and illustrated by curves of noise intensity as a function of frequency. Observations made on a thyratron tube in a magnetic field which was applied transversely to the current were also in agreement with

the theory. The experiments demonstrate the value of the theory in predicting new phenomena and supply a rough model of a sunspot emitter of enhanced solar noise. (M.S.C.)

A2-50-03 Buneman, O. "Generation and Amplification of Waves in Dense Charged Beams Under Crossed Fields," Nature, 165, 474-476 (Mar. 25, 1950).

By the use of plane electrodes without resonators or corrugations, a dense beam of charged particles may be made to produce oscillations similar to those in magnetrons; the process is purely electrostatic and can occur at low fields and low frequencies. The conclusions of a theoretical study of this phenomenon are discussed and expressions are given for the electric field distribution, the transverse particle-velocity distribution, the wave velocity along the beam, and, in the case of a feedback system, the resonance frequency and amplification. The system may have value as a simple generator or amplifier for microwaves and the mechanism may possibly explain the production of solar noise. (W)

A2-50-04 Denisse, J. F. "Contribution à l'Étude des Émissions Radioélectriques Solaires," Annales d'Astrophysique, 13, 181-202 (Apr.-June, 1950).

The essential characteristics of the solar radio-frequency emissions are described, and the various theories which have been proposed in order to explain them are reviewed. On the basis of assumed distributions of the temperature and electron density in the solar atmosphere, the emission of the quiet sun on various radio frequencies is calculated. The theoretical results compare satisfactorily with experimental data for the corona, and confirm its high degree of excitation. Interpretation of the chromospheric emissions on wavelengths of 1 to 25 centimeters, however, requires the temperature of the lower corona to be very much less than that deduced from optical measurements. The slow fluctuations of intensity on wavelengths of the order of 10 centimeters are explained by the gyromagnetic effect associated with the magnetic fields of the sunspots. The observed emission, which is proportional to the area of the spots, corresponds in their neighborhood to a coronal temperature exceeding 4×10^6 degrees. Other variations of intensity are of two types, those which are associated with variations in the topography of the spots and those which are associated with flares. On the short wavelengths, the latter probably originate from temporary increases of electron temperature, while for the longer wavelengths an explanation involving the motion of jets of ionized particles in the solar atmosphere seems more plausible. Prominences undoubtedly influence the radio-frequency radiation but their effect is difficult to evaluate. (A; M.S.C.)

A2. RADIATION FROM THE SUN: Theories and Interpretations

A2-50-05 Denisse, J. F. "Émissions Radioélectriques d'Origine Purement Thermique dans les Milieux Ionisés," Journal de Physique et le Radium, 11, 164-171 (Apr., 1950).

This study of the emission of radio-frequency waves by ionized mediums is restricted to emissions of purely thermal nature, i.e., to emissions by "hyperbolic" transitions and to gyromagnetic emissions which occur in the presence of a magnetic field. In the calculation of the coefficient of emission, the classical and quantum points of view have been combined; the resulting expression is more general than those which have been given previously and is valid for all cases. The absorption calculated by Lorentz is shown to be identical with the absorption which results from hyperbolic transitions, and this identity permits a study of the influence of the index of refraction of the medium on the emissions by hyperbolic transitions. (A; M.S.C.)

A2-50-06 Jaeger, J. C., and Westfold, K. C. "Equivalent Path and Absorption for Electromagnetic Radiation in the Solar Corona," Aust. J. Sci. Res. A, 3, 376-386 (Sept., 1950).

The trajectories, equivalent path, and absorption of rays in the solar corona have been calculated for frequencies ranging from 20 to 100 Mc./s., possible magnetic fields being neglected and spherical symmetry assumed. The double-humped burst of solar noise is interpreted to be the superposition of a direct and an echo signal, and inferences concerning the position of its source, expressed as height in the corona and location on the solar disk, are made. (A)

A2-50-07 Korff, S. A., and Beers, Y. "The Solar Atmosphere and the Origin of Radiofrequency Radiation," Phys. Rev., 80, 489-490 (Nov. 1, 1950).

Attention is called to three physical considerations pertinent to the interpretation of measurements of solar radio noise: (1) the sun's atmosphere is not in equilibrium; (2) radiation pressure is more important than thermal collisions in supporting the outer atmosphere; (3) no direct physical significance can be attached to the equivalent noise temperature. (M.S.C.)

A2-50-08 Kwal, Bernard. "Les Ondes Electromagnétiques, Emises par les Protons Rapides dans les Champs Magnétiques Intenses, et la Corrélation entre le Rayonnement Cosmique et les Bruits Radio-Électriques du Soleil et de la Galaxie," Comptes Rendus, 231, 1057-1059 (Nov. 13, 1950).

The classical theory of the radiation of a charged particle in a magnetic field indicates that, in fields of the order of 10^3 to 10^4

gauss, protons of 10^9 to 10^{10} eV radiate in the meter and centimeter band. It therefore seems possible to associate the solar and galactic radio noise with the acceleration of cosmic rays in sunspots and in "starspots." (A: M.S.C.)

A2-50-09 Malmfors, K. G. "Unstable Oscillations in an Electron Gas," Arkiv for Fysik, 1, Part 6, 569-578 (1950).

A system of electrons, all of which move with the same velocity perpendicular to a magnetic field, is shown to be unstable. Small primary distortions are rapidly amplified and give rise to large density variations accompanied by electric fields within the electron gas and by the emission of electromagnetic radiation. This type of process may be the source of the observed solar and galactic noise. (M.S.C.)

A2-50-10 Piddington, J. H. "The Derivation of a Model Solar Chromosphere from Radio Data," Proc. Roy. Soc. A, 203, 417-434 (Oct. 10, 1950).

An empirical relationship between the equivalent black-body temperature of the sun's disk and the radio frequency is derived. The formula is applicable for frequencies between about 600 and 24,000 Mc./s. An expression for the absorption coefficient of radio waves in the solar atmosphere is developed so that, by Kirchhoff's principle, it is possible to determine the emission from each level and hence the overall emission in terms of known or assumed conditions. The coronal and chromospheric components of radiation are separated and their distributions over the solar disk are determined theoretically. The conclusions are compared with experimental results and found to be in sufficiently good agreement for the present purposes. From the reduced radio data an equation is derived relating the optical depth of a given level in the chromosphere with electron temperature at that level. Optical depth may be expressed as a function of electron temperature and density so that the equation may be used to check the validity of any proposed model chromosphere. By combining the radio results with optical data in the form of intensities of spectrum lines at various levels, a determination of electron density and temperature over a range of levels from about 5000 to 15,000 kilometers is made. The radio results are difficult to reconcile with Redman's estimate of an electron temperature of 30,000 °K at 1500 kilometers. A marked departure from conditions of hydrostatic equilibrium is indicated. (A)

A2-50-11 Smerd, S. F. "Radio-Frequency Radiation from the Quiet Sun," Aust. J. Sci. Res. A, 3, 34-59 (Mar., 1950).

The equation of transfer of radiation is used in a ray treatment of

radio-frequency radiation from the solar atmosphere in the absence of solar activity. The chromosphere and the corona are represented as regions of uniform temperature. However, a range of temperatures is considered in order to allow for uncertainties in the temperature distribution in the solar atmosphere. The intensity distribution across the solar disk is shown to depend significantly on the coronal temperature. Both limb-brightening and limb-darkening can occur but are appreciable only when the corona is optically thin, yet not transparent. A measure of the size of the radio-frequency disk is obtained in terms of the size of the optical disk. The apparent temperature is found to reach a maximum as a function of frequency for each coronal temperature and as a function of coronal temperature for each frequency. Within the limits of experimental error all observed apparent temperatures fall within the range of theoretical values corresponding to chromospheric temperatures from 10^4 to 3×10^4 °K and coronal temperatures from 2.5×10^5 to 3×10^6 °K. The effects of a possible general magnetic field of the sun are estimated in selected cases and found to be small in relation to those due to the uncertainties in the temperature of the solar atmosphere. (A)

A2-50-12 Smerd, S. F. "The Polarization of Thermal 'Solar Noise' and a Determination of the Sun's General Magnetic Field." Aust. J. Sci. Res. A, 3, 265-273 (June, 1950).

The equation of transfer of radiation and the magneto-ionic theory are used to derive expressions for the degree of polarization of thermal solar noise due to a general magnetic field of the sun. In particular, the net polarization of 600-megacycle radiation corresponding to the maximum phase of the eclipse of November 1, 1948, as seen from Melbourne, Victoria, is evaluated theoretically and compared with observational evidence. This leads to an upper limit of 11 gauss for the surface field-strength at the solar poles at the time of observation. (A)

A2-50-13 Smerd, S. F. "A Radio-Frequency Representation of the Solar Atmosphere." Proc. I. E. E. III, 97, 447-452 (Nov., 1950).

A collection of solar data, derived from optical observations and originally compiled for use in studies of solar noise, is presented. An elementary description of the solar atmosphere is followed by mean values of the electron density, electron temperature, and magnetic field as functions of height in the chromosphere and corona. An assumed general magnetic field, and magnetic fields due to sunspots are each treated. The data are finally presented in terms of plasma, gyro, and collision frequencies, all of which are fundamental to the magneto-ionic theory. Levels of zero refractive index and their significance are discussed, and the effect of prominences is considered. (A)

A2. RADIATION FROM THE SUN: Theories and Interpretations

A2-50-14 Twiss, R. Q. "On Bailey's Theory of Growing Circularly Polarized Waves in a Sunspot," Phys. Rev., 80, 767-768 (Nov. 15, 1950).

Bailey's theory (see A2-50-01) of the amplification of circularly polarized waves in an ionized medium is criticized. Conditions in the sun are such that this theory appears unable to account for the observed noise from sunspots. (M.S.C.)

A2-50-15 Waldmeier, M., and Muller, H. "Die Sonnenstrahlung im Gebiet von λ = 10 Cm.," Zeitschrift fur Astrophysik, 27, No. 1, 58-72 (1950).

The solar radiation on a wavelength of 10 centimeters consists of two components: a radiation of constant intensity arising from the chromosphere and the corona, and a radiation of variable intensity showing a close correlation with sunspot numbers. At times of high solar activity the two components are of about equal intensity. The variable component is interpreted as thermal radiation of the so-called "coronal condensations," regions of exceptionally high electron density around sunspot groups. (A)

A2-50-16 Westfold, K. C. "The Refractive Index and Classical Radiative Processes in an Ionized Gas," Phil. Mag., 41, 509-516 (June, 1950).

The role of the refractive index in the classical theory of radiation in an ionized gas is investigated. The Lorentz formula for the macroscopic absorption coefficient is recovered from microscopic considerations, and the heuristic modification of the formula for the emissivity obtained in a previous paper [see A2-49-13] is justified. The consequent modification of the free-free transition probabilities is indicated. (A)

A2-50-17 Woolley, R. v. d. R., and Allen, C. W. "Ultra-Violet Emission from the Chromosphere," M. N., 110, No. 4, 358-372 (1950).

A model of the quiet chromosphere is constructed which gives as good a fit as found possible to data from eclipse observations and to observations of solar radio noise and of the ionosphere, everything being taken at minimum solar disturbance. The model has spherical symmetry and a single value of the kinetic temperature at every height. In the model there is a sharp division between the lower chromosphere, at heights below 6000 kilometers, in which the temperature is 5040°, and the upper chromosphere in which the temperature ascends at first very rapidly. It is estimated that the chromosphere emits about 7×10^{14} quanta capable of ionizing terrestrial gases per square centimeter per second, of which 6×10^{14}

are emitted in line spectra of ions such as O VI, O V, N V, etc., and the remainder in the Lyman continuum of H. About half the quanta have an energy greater than 13.6 volts, and are therefore capable of ionizing O to O^+ in the ionosphere. The energy is supplied by conduction inwards from the corona. (A)

See also: A1-50-14, A1-50-15, M-50-01, M-50-10, R-50-10, R-50-13, and R-50-14.

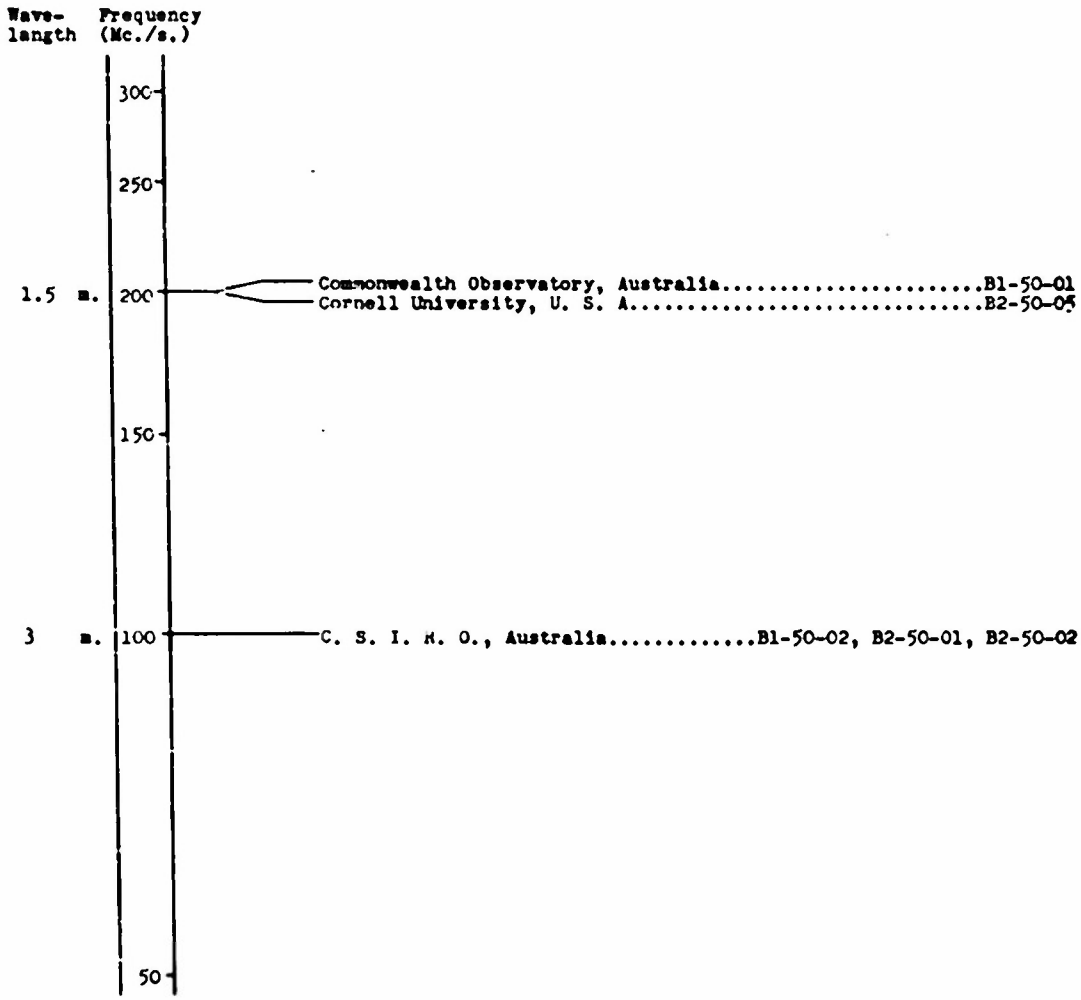
SECTION B

GENERAL GALACTIC RADIATION

Part 1. Observations

GENERAL GALACTIC RADIATION

SUPPLEMENTARY SUMMARY OF OBSERVED WAVELENGTHS*



* For explanation see page 3.

B1. GENERAL GALACTIC RADIATION: Observations

B1-50-01 Allen, C. W., and Gum, C. S. "Survey of Galactic Radio-Noise at 200 Mc/s.," Aust. J. Sci. Res. A, 3, 224-233 (June, 1950).

A survey of galactic radio noise on 200 Mc./s. has been made for the region of the sky south of declination $+45^{\circ}$. Results are expressed graphically in watts m.$^{-2}$ (c./s.)$^{-1}$ steradian^{-1}, the maximum value being 20×10^{-21} watt m.$^{-2}$ (c./s.)$^{-1}$ steradian^{-1} at galactic latitude -3° and longitude 322°. Corrections have been made for the beam-width of the antenna. No measurement has been made of the residual intensity from the coldest parts of the sky (the galactic poles) and this quantity, when known, should be added to the results quoted. The galactic noise provides a permanent and convenient standard for solar noise measurements, and its intensity for this purpose is evaluated. (A)

B1-50-02 Bolton, J. G., and Westfold, K. C. "Galactic Radiation at Radio Frequencies. I. 100 Mc/s. Survey," Aust. J. Sci. Res. A, 3, 19-33 (Mar., 1950).

A survey of galactic radiation on a frequency of 100 Mc./s. is described. An antenna array with a 17-degree beamwidth, on an equatorial mounting, was used to plot the distribution of intensity over the section of the celestial sphere between declinations $+30^{\circ}$ and -90°. The method of eliminating the effect of the polar diagram of the antenna from the observations is described, and the final distribution, expressed in terms of equivalent black-body temperature, is presented in galactic coordinates on a series of equal-area charts. (A)

See also: B2-50-01, B2-50-02, B2-50-05, and M-50-01.

SECTION B

GENERAL GALACTIC RADIATION

Part 2. Theories and Interpretations

B2. GENERAL GALACTIC RADIATION: Theories and Interpretations

B2-50-01 Bolton, J. G., and Westfold, K. C. "Structure of the Galaxy and the Sense of Rotation of Spiral Nebulae," Nature, 165, 487-488 (Mar. 25, 1950).

The distribution of the intensity of galactic noise over the entire celestial sphere has been determined from surveys by the authors (see B1-50-02), by Hey, Parsons, and Phillips (see B1-48-02), and by Reber (see B1-44-01), on frequencies of 100, 64, and 160 Mc./s. respectively. After corrections are applied for the intense discrete sources in Cygnus and Cassiopeia, the resulting distribution along the galactic equator shows an extended principal maximum in the direction of the galactic center and a sharp secondary maximum in Cygnus. The observations place the sun in or near a spiral arm which extends from Carina to Cygnus, and appear to indicate that the sense of rotation of the galaxy is that of a spiral unwinding. [For a more detailed account see B2-50-02.] (M.S.C.)

B2-50-02 Bolton, J. G., and Westfold, K. C. "Galactic Radiation at Radio Frequencies. III. Galactic Structure," Aust. J. Sci. Res. A, 3, 251-264 (June, 1950).

The structure of the galaxy is investigated on the assumption that the intensity of the galactic noise in any direction is a measure of the spatial extent of the galaxy in that direction. The analysis of surveys of galactic radiation on several radio frequencies indicates a primary maximum in the direction of the galactic center, and a sharp secondary maximum in Cygnus. The observations lead to the conclusion, consistent with optical evidence, that the sun is in or near a spiral arm which opens outward in the direction from Carina toward Cygnus. The sense of rotation of the galaxy is deduced to be that of a spiral unwinding, a result in agreement with the theories of Lindblad and Milne. A possible, approximately ellipsoidal, shape for the nucleus of the galaxy is derived. (M.S.C.)

B2-50-03 Kiepenheuer, K. O. "Cosmic Rays as the Source of General Galactic Radio Emission," Phys. Rev., 79, 738-739 (Aug. 15, 1950).

Electrons in the general cosmic radiation of the galaxy may be expected to radiate electromagnetic energy by reason of their motions in magnetic fields in interstellar space, and are proposed as the source of the galactic radio emission. The intensity of the emission, predicted on the basis of reasonable assumptions concerning the thickness of the emitting layer and the density and energies of the electrons concerned, agrees in order of magnitude with the observations of Hey, Parsons, and Phillips. Fermi's hypothesis that cosmic rays and galactic matter have more or less the same distribution is supported. (M.S.C.)

B2. GENERAL GALACTIC RADIATION: Theories and Interpretations

B2-50-04 Kiepenheuer, K. O. "[Abstract:] Cosmic Rays and Radio Astronomy," Astronomical Journal, 55, 172-173 (Oct., 1950).

The hypothesis that electrons in the general cosmic radiation of our galaxy are the source of the galactic radio emission is proposed and discussed. [The treatment is very similar to that in B2-50-03.] (M.S.C.)

B2-50-05 Williamson, Ralph E. "Concerning the Source of Galactic Radio Noise," J. R. A. S. C., 44, 12-16 (Jan.-Feb., 1950).

The hypothesis that the radio-frequency radiation of the galaxy is caused by free-free transitions of electrons in the field of interstellar protons is tested by a method which is independent of the absolute intensities of the signals. From observed values of the range of galactic latitude within which the intensity exceeds one-half its maximum value, the opacity is calculated for six frequencies ranging from 20.5 to 480 Mc./s. An empirical dependence of opacity on $(\text{frequency})^{-0.7}$ is deduced, whereas the theory of free-free transitions predicts a proportionality to $(\text{frequency})^{-2.0}$. (M.S.C.)

See also: A2-50-05, A2-50-08, A2-50-09, A2-50-16, C1-50-04, M-50-01, M-50-07, and R-50-13.

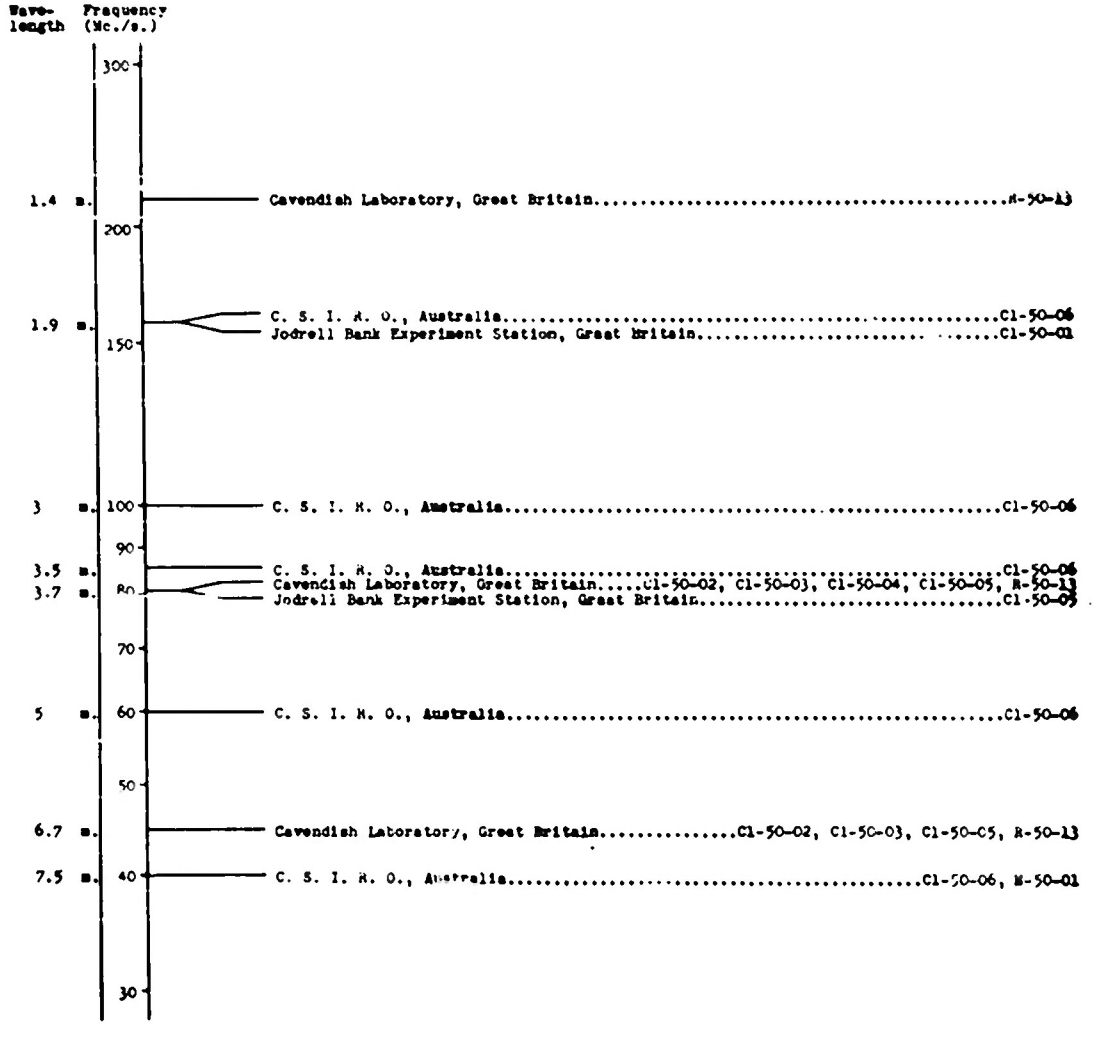
SECTION C

RADIATION FROM "DISCRETE SOURCES"

Part 1. Observations

RADIATION FROM "DISCRETE SOURCES"

SUPPLEMENTARY SUMMARY OF OBSERVED WAVELENGTHS*



* For explanation see page 3.

C1. RADIATION FROM "DISCRETE SOURCES": Observations

C1-50-01 Brown, R. Hanbury, and Hazard, C. "Radio-Frequency Radiation from the Great Nebula in Andromeda (M.31)," Nature, 166, 901-902 (Nov. 25, 1950).

The results of an experiment to detect radiation from the Andromeda Nebula on a frequency of 158.5 Mc./s. are reported. The measurements were made with a paraboloid antenna having an aperture of 218 feet, a focal length of 126 feet, and a beamwidth of about 2°. A localized source of radiation at right ascension $0^{h}\ 40^{m} \pm 2^{m}$ and declination $+40^{\circ}\ 55' \pm 20'$ was found; its dimensions are $45' \pm 10'$ and $25' \pm 10'$ along the right ascension and declination axes respectively, and its effective black-body temperature is of the order of 1000°. The combined evidence indicates with high probability that the observed source is the Andromeda Nebula, and is comparable, so far as radio emission is concerned, to our own galaxy. (M.S.C.)

C1-50-02 Royal Astronomical Society. "Meeting of the Royal Astronomical Society [May 12, 1950]," Observatory, 70, 129-138 (Aug., 1950). [Material pertaining to extraterrestrial radio noise on pages 135-138.]

An account of recent work on radio astronomy at the Radiophysics Laboratory in Sydney was presented by J. G. Bolton. [M.] Ryle reported new information concerning the fluctuations of the radiation from discrete sources in the galaxy; some of the fluctuations show a diurnal variation on wavelengths of 3.7 and 6.7 meters, and originate from diffraction caused by regions of irregular ionization in the F-layer of the ionosphere. [For a detailed account see C1-50-03.] A new diffraction theory of scintillation, described at this meeting by [C. G.] Little, predicts the occurrence of radio scintillations if electron clouds which extend over a few kilometers and differ in refractive index from the surrounding ionosphere by less than 1 in 1000 are present. (M.S.C.)

C1-50-03 Ryle, M., and Hewish, A. "The Effects of the Terrestrial Ionosphere on the Radio Waves from Discrete Sources in the Galaxy." M. N., 110, No. 4, 381-394 (1950).

Observations of the discrete sources of radio waves in the galaxy have shown the existence of irregular refraction processes in the terrestrial ionosphere. These irregularities cause rapid fluctuations in the intensity of the radiation at the ground, while observations with antennas of high resolving power have shown, in addition, that the apparent position of a source may vary irregularly by 2 or 3 minutes of arc. The incidence of these irregularities shows a marked diurnal variation having a maximum at about $01^{h}\ 00^{m}$ local time. It does not seem possible to account for the irregularities in the

ionosphere in terms of solar emissions, and an alternative mechanism is proposed which is based on the interception of interstellar matter moving under the gravitational attraction of the sun. If this hypothesis is correct, further experiments may provide information of interest in theories of the accretion of matter by the sun. (A)

C1-50-04 Ryle, M., Smith, F. G., and Elsmore, B. "A Preliminary Survey of the Radio Stars in the Northern Hemisphere," M. N., 110, No. 6, 508-523 (1950), and errata, 111, No. 6, 641 (1951).

Observations [on a wavelength of 3.7 meters] with an interferometer of large resolving power have made it possible to locate 50 discrete sources of radio waves in the northern hemisphere; their positions and intensities (which cover a range of 7½ in apparent magnitude) are given. The positions of the more intense of these "radio stars" can be determined with an accuracy of about 5', but most of them can only be located to within 1°. The angular distribution of the radio stars, unlike that of the general background radiation, shows no concentration in the galactic plane; this result suggests either that they are at distances small compared with the dimensions of the galaxy, or that they are situated outside the galaxy. While there is evidence that a few of the weakest radio stars represent the total "background" radiation of some of the nearest extragalactic nebulae, it is concluded that the majority of the radio stars must be situated within the galaxy. Estimates of the relative intensities of the radio stars and of the background radiation have suggested that they are distributed throughout the galaxy with an average population density comparable with that of visual stars. Attempts to identify the radio stars with various types of visual body have been unsuccessful; it is therefore concluded that the radio star represents a hitherto unobserved type of stellar body which is distributed widely throughout the galaxy and is equally numerous in other spiral nebulae. (A)

C1-50-05 Smith, F. G.; Little, C. G., and Lovell, A. C. B. "Origin of the Fluctuations in the Intensity of Radio Waves from Galactic Sources," Nature, 165, 422-424 (Mar. 18, 1950).

The radio emissions of the sources in Cygnus and Cassiopeia were observed on a wavelength of 6.7 meters with two spaced receivers operating simultaneously at stations separated by distances up to 170 kilometers. Rapid fluctuations, involving variations of intensity both above and below the mean level, occurred on many nights. They showed no detailed correlation when the receivers were separated by more than 20 kilometers, and were probably caused by diffraction in a comparatively local region. Occasional "bursts," characterized by large amplitudes and by durations of 10 to 20 seconds, were well correlated even when the receivers were widely separated, and appear

to have resulted from genuine variations of the emission of the sources. Similar experiments on a wavelength of 3.7 meters were also performed. When the receivers were separated by a distance of 210 kilometers, the radiation on the shorter wavelength was generally found to be either steady at both sites, or fluctuating at both sites, the fluctuations in the latter case being uncorrelated. For a separation of 100 meters the correlation was complete, while for a separation of 3.9 kilometers the correlation was incomplete but high, and variable in amount. The phase reversal of an appreciable fraction of a Fresnel zone by localized changes in the refractive index of the ionosphere is a possible mechanism for the production of the observed fluctuations. (M.S.C.)

C1-50-06 Stanley, G. J., and Slee, O. B. "Galactic Radiation at Radio Frequencies. II. The Discrete Sources," Aust. J. Sci. Res. A, 3, 234-250 (June, 1950).

An account of observations on a number of discrete sources of radio-frequency radiation is given, together with a brief description of the observational techniques used in the detection of these sources, and of the methods employed to determine their positions and angular extent. Noise spectra of four of the more intense sources have been measured over a frequency range of 40 to 160 Mc./s.; in three cases the change of intensity with wavelength is found to be greater than that of the background continuum, and in one case less. Two of the sources have been provisionally identified with astronomically rare objects, the Crab Nebula and NGC 5128. Finally, the short-period fluctuations in the intensity of some of the sources, notably that in Cygnus, are discussed. Evidence here presented suggests, contrary to previous views, that these fluctuations are of terrestrial rather than of extraterrestrial origin. (A)

See also: M-50-01 and R-50-13.

SECTION C

RADIATION FROM "DISCRETE SOURCES"

Part 2. Theories and Interpretations

C2. RADIATION FROM "DISCRETE SOURCES": Theories and Interpretations

C2-50-01 Alfvén, H., and Herlofson, N. "Cosmic Radiation and Radio Stars," Phys. Rev., 78, 616 (June 1, 1950).

The production of the emission of radio stars, such as the source in Cygnus, is attributed to cosmic-ray electrons in the "trapping fields" of stars of low visual luminosity. For the emission of meter waves, the required magnetic field is about 100 times as great as the estimated strength of the sun's trapping field. This indicates that the radio star should be situated in an interstellar cloud whose relative motion is rather rapid. (M.S.C.)

C2-50-02 Menzel, Donald H., and Crowley, Daniel J. "Point Sources of Radio Noise," Nature, 165, 443 (Mar. 18, 1950).

The assumption that the intense point sources of radio noise have a galactic or stellar origin fails to explain: (1) their widely scattered distribution on the sky, and (2) the enormous rates at which they radiate if they are at stellar distances. A possible alternative interpretation is that the radiations emanate from giant, long-period comets which absorb solar ultraviolet and X- radiation and convert it, perhaps by plasma-type oscillations, to radio noise. The detection of measurable parallax would prove that the sources are part of the solar system. (M.S.C.)

C2-50-03 Shklovsky, I. S. "On the Possibility of the Determination of the Distance of the 'Point' Sources of Galactic Radio Radiation" [In Russian], Doklady Akademii Nauk S. S. S. R., 73, No. 3, 479-481 (1950).

A method is developed for determining the distances of the "point" sources of galactic radiation by analysis of the real fluctuations of intensity on different wavelengths. (P:L.J.Goodlet)

See also: C1-50-02, C1-50-03, C1-50-04, C1-50-05, C1-50-06, and R-50-13.

SECTION D

RADIATION FROM THE MOON

D. RADIATION FROM THE MOON

D-50-01 "In Focus," Sky and Telescope, 9, 50, and cover photograph on page 49, (Jan., 1950).

A radio telescope with a parabolic reflector 30 inches in diameter was used to observe the temperature of the moon on a wavelength of 1.25 centimeters during the two lunar eclipses of 1949. This instrument, which was developed by the Collins Radio Company and is here pictured and described, can detect a variation in temperature of approximately one degree centigrade. There was no significant change in the observed radio temperature of the moon during totality, a result which supports the conclusion that the moon's surface material is fine dust. The observations were made under the direction of W. W. Salisbury and communicated by D. O. McCoy. (M.S.C.)

SECTION M

MISCELLANEOUS

M. MISCELLANEOUS

M-50-01 Australian National Committee of Radio Science, U. R. S. I. "Summary of Proceedings of Australian National Committee of Radio Science, URSI, Sydney, January 16-20, 1950," J. Geophys. Res., 55, 191-210 (June, 1950). [Material pertaining to extraterrestrial radio noise on pages 198-209.]

Abstracts of thirty-three papers, of which more than one-third pertain to extraterrestrial radio noise, are given, and the discussions which followed their oral presentation are reported. Among the papers summarized are the following: "The Origin of Galactic Radio-Frequency Radiation," by J. H. Piddington; "Some Characteristics of Non-Thermal Solar Radiation at Metre Wavelengths," by Ruby Payne-Scott; "International Co-operation and the Publication of Solar Radio-Noise Information," by C. W. Allen; "Proper Fields for Radio Astronomy," by J. L. Pawsey; "The Growth and Escape of Plane-Polarised Waves from the Neighbourhood of a Bipolar Sunspot," by R. F. Mullaly; and additional papers by J. G. Bolton, C. W. Allen, S. F. Smerd, W. N. Christiansen, J. C. Jaeger and K. C. Westfold, J. P. Wild, and V. A. Bailey, on subjects which are discussed in more detail elsewhere [see especially A1-49-02, A1-50-14, A1-50-15, A1-50-16, A2-50-02, A2-50-06, A2-50-11, B1-50-01, B1-50-02, B2-50-01, B2-50-02, and C1-50-06.] (M.S.C.)

M-50-02 Broxon, James W., and Boehmer, Howard W. "Cosmic-Ray Intensity Following a Solar Flare," Phys. Rev., 78, 411-414 (May 15, 1950).

Continuous records of cosmic-ray intensity, measured by a heavily shielded, high-pressure ion chamber, show no unusual occurrences on May 10, 1949, at or near the time of an intense solar flare of importance 3+. The flare was accompanied by bursts of solar noise (see A1-49-18) and was followed by an intense magnetic storm. On May 12, at the peak of the magnetic storm, the intensity of the cosmic radiation decreased by about 1.5 percent. (M.S.C.)

M-50-03 Bureau, R. "Les Renforcements Brusques des Ondes Très Longues," Proc. Phys. Soc. B, 63, 122-126 (Feb. 1, 1950), abstracted in French on page 147 of same issue.

Enhancements of the mean level of atmospherics on a wavelength of 11 kilometers have been associated with other phenomena such as simultaneous fade-outs of the field intensity of stations on decametric wavelengths, perturbations of terrestrial magnetism, or Wolf numbers relative to solar activity. A search was recently made for occasions on which the association between the different phenomena is not so close. The fade-out on short waves is sometimes preceded by a brief enhancement which is probably due to the reception of radio-frequency radiation from the sun. Examples of

this phenomenon occurred on February 8, 1946, December 28, 1948, April 5, 1949, and May 7, 1949. (A; M.S.C.)

M-50-04 Cottony, Herman V. "Radio Noise of Ionospheric Origin," Science, 111, 41 (Jan. 13, 1950).

Numerous occurrences of sustained high-level noise have been detected in the course of cosmic noise measurements made with broad-beam antennas operated on frequencies of 25, 50, 75, and 110 Mc./s. A solar radiometer equipped with a 25-foot Wurzburg parabola and adjusted to a frequency of 50 Mc./s. was in one instance employed to investigate the source of this noise. The radiations were found to come not from the sun but from the entire sky, a result suggesting an origin in the outer atmosphere of the earth. No unusual disturbances were detected with a solar radiometer operated simultaneously on 480 Mc./s. (M.S.C.)

M-50-05 Covington, A. E. "Microwave Sky Noise," J. Geophys. Res., 55, 33-37 (Mar., 1950).

Two radiometers with separate antennas, one directed toward the zenith and the other directed toward the sun, have been used simultaneously for the measurement of microwave radiation. Intense bursts of the radiation from the zenith as well as small fluctuations below and above the general sky level have occurred in association with certain geomagnetic disturbances. Examples which took place on June 20, 21, and 22, 1946, March 27 and 28, 1947, April 23, 1947, May 21, 1947, and August 4, 1948, are described. Such phenomena are now believed to occur less frequently than was previously implied (in M-47-02). (M.S.C.; A)

M-50-06 Gutmantsev, G. G., and Ginsburg, V. L. "On the Diffraction of Solar and Cosmic Radio Radiation on the Moon" [In Russian], Zhurnal Eksperimental'noĭ i Teoreticheskoĭ Fiziki, 20, No. 4, 347-350 (1950).

A problem of radio astronomy, namely the comparatively low angular resolving power of receiving systems, whether operated with single or spaced antennas, is discussed. In the best of cases, i.e., with an antenna raised to about 1.5 kilometers above ground or sea level, the separation obtainable is about 3', which is quite insufficient to localize the origin of an individual noise signal. For example, in the case of a certain nebula of dimensions of the order of 5', it is impossible to say whether the noise is due to the nebula as a whole or to any individual star or star group in it. A suggested method, using diffraction of the radio waves on the limb of the moon, is shown to improve these conditions, so that in certain

favorable circumstances separations of the order of 2" could be obtained. The method can be used only for solar observations during eclipses, and for cosmic objects when they are covered by the moon. A further refinement may on principle be achieved by "central-spot diffraction," though the experimental difficulties would be far greater. (P.B.F.Kraus)

M-50-07 Hall, John S., and Mikesell, A. H. "Polarization of Light in the Galaxy as Determined from Observations of 551 Early-Type Stars," Pub. U. S. Naval Obs., 17, Part 1, 1-62 (1950). [Material pertaining to extraterrestrial radio noise on page 61.]

Measurements of the polarization of the light of 551 stars, most of which are of spectral type B and characterized by large color excess, are reported. Within certain regions along the galactic circle, the stars show a close similarity both in percentage polarization and in position angle of the plane of polarization. In other regions at low galactic latitudes, the polarizations are heterogeneous and small. Regions of intense galactic radio noise and regions of complex interstellar lines are of the second type. (M.S.C.)

M-50-08 "Naval Research Laboratory Eclipse Expedition," Sky and Telescope, 9, 262 (Sept., 1950).

Plans for the observation of the total solar eclipse of September 12, 1950, by an expedition from the Naval Research Laboratory, are briefly described. At Attu, the westernmost island of the Aleutian chain, the sun's radio emission during the eclipse will be measured on wavelengths of 0.85, 3.15, 10.7, and 64.5 centimeters. The observations will be particularly useful for the study of the electron density and temperature gradients in the solar atmosphere. (M.S.C.)

M-50-09 Royal Astronomical Society. "Meeting of the Royal Astronomical Society [Oct. 13, 1950]." Observatory, 70, 201-208 (Dec., 1950). [Material pertaining to extraterrestrial radio noise on pages 202-203.]

In describing current work at the National Observatory, University of Tokyo, Y. Hagihara reported that continuous records of solar radio noise on a frequency of 200 Mc./s. are regularly obtained. J. L. Pawsey outlined the past and present research program on radio astronomy at the Radiophysics Laboratory, C. S. I. R. O., Australia, and briefly reviewed some of the findings of the staff. Outward velocities of several hundred kilometers per second have been attributed to the disturbing agencies which give rise to solar

outbursts and which are postulated to be magnetic-storm particles (see A1-50-14); directional observations using a new interference technique confirm such motions. (M.S.C.)

M-50-10 van de Hulst, H. C. "The Electron Density of the Solar Corona," B. A. N., 11, No. 410, 135-150 (Feb. 2, 1950).

A new discussion of the brightness, electron density, and polarization of various parts of the corona is presented, and mutually consistent values of these quantities are tabulated. The tables are called the "model corona"; it is hoped that future changes will be small and that their discussion will require little effort. The need for such data has been felt in particular in investigations of solar radio waves. (A; M.S.C.)

SECTION R

REVIEWS

R. REVIEWS

R-50-01 British Astronomical Association. "Report of the Ordinary General Meeting of the Association [Jan. 25, 1950]," J. B. A. A., 60, 93-102 (Mar., 1950). [Material pertaining to extraterrestrial radio noise on pages 99-100.]

The moon's temperature has been determined both by the use of thermocouples and by measurement of the moon's radiation on a wavelength of 1.25 centimeters (see D-49-01). Short summaries, by A. C. Clarke and M. W. Ovenden, of the methods and results of these two types of measurement are reported. (M.S.C.)

R-50-02 d'Azambuja, M. L. "Les Progrès Récents de l'Astronomie," Astronomie, 64, 296-302 (July-Aug., 1950). [Material pertaining to extraterrestrial radio noise on pages 299-300.]

Ryle's investigations concerning the radio-frequency emissions from discrete galactic sources are briefly described, together with important developments in other branches of astronomy. (M.S.C.)

R-50-03 Institute of Radio Engineers. "Radio Astronomy" (Subsection of "Radio Progress During 1949"), Proc. I. R. E., 38, 388-390 (Apr., 1950).

Advances during 1949 are briefly summarized under the headings, "Galactic Radio Waves," "Solar Radio Waves," and "Reviews." Appropriate papers are listed. (M.S.C.)

R-50-04 International Scientific Radio Union (Union Radio Scientifique Internationale). Special Report No. 1 on Solar and Galactic Radio Noise. Brussels, General Secretariat of U. R. S. I., [1950]. 47 pages.

A detailed report on present knowledge concerning radio noise of extraterrestrial origin is presented. The report is divided into three sections. The first section gives the development of a number of theoretical relationships which pertain to the interaction of radio antennas and electromagnetic fields and which provide the basis for the experimental work described in the later sections. The second and third sections contain descriptions of both the experimental facts and the suggested theoretical explanations concerning solar and galactic radio noise. (M.S.C.)

R-50-05 Lovell, A. C. B. "Radio Waves from the Milky Way," Listener, 44, 11-12 (July 6, 1950).

A short account of early studies of galactic radio emissions is followed by an elementary discussion of radio stars. (M.S.C.)

R. REVIEWS

R-50-06 Nicolet, M. "Bruits Solaires," "Scientia", 85, No. 454, 37-41 and Nos. 455-456, 71-77 (1950).

Observational investigations leading to the present knowledge of solar radio emissions are summarized. Introductory remarks concerning the discovery of radio noise of extraterrestrial origin are followed by descriptions of the characteristics of the "undisturbed" solar radiation, the slow fluctuations of intensity, bursts, and outbursts. Results obtained on various wavelengths in the centimeter and meter range are compared. The sequences of solar and terrestrial phenomena which occurred during the exceptionally active periods in February and July, 1946, are discussed. (M.S.C.)

R-50-07 Öpik, E. "The Sense of Rotation of Spiral Nebulae," Irish Astronomical Journal, 1, 63-64 (June, 1950).

A statement of the difficulty of determining the direction of rotation of spiral nebulae is followed by a brief account of the tentative conclusions (see B2-50-01) reached by Bolton and Stanley from consideration of the distribution of galactic radio noise. (M.S.C.)

R-50-08 Ovenden, Michael W. "Astronomy" (Section of "Recent Advances in Science"), Science Progress, 38, 275-283 (Apr., 1950). [Material pertaining to extraterrestrial radio noise on pages 275-280.]

The results (reported in C1-48-01, C1-48-02, C1-48-03, C1-49-02, and D-49-02) of Australian investigations dealing with the discrete sources of radio emission and with the microwave radiation of the moon, are summarized. "Flare stars," considered to be possible sources of radio emission, are briefly described. (M.S.C.)

R-50-09 Ovenden, Michael W. "Astronomy" (Section of "Recent Advances in Science"), Science Progress, 38, 475-483 (July, 1950). [Material pertaining to extraterrestrial radio noise on pages 477-479.]

The radio "twinkling" reported by Smith, Little, and Lovell (in C1-50-05) is discussed. (M.S.C.)

R-50-10 Pawsey, J. L. "Solar Radio-Frequency Radiation," Proc. I. E. E. III, 97, 290-308, and discussion on pages 308-310, (Sept., 1950).

A survey of research on solar radio-frequency radiation from the time of its discovery until early 1948 is presented. After an introduction concerned with history and units for specification of intensity, the observed characteristics of solar noise in the wavelength range from

1 centimeter to some meters are described. These include intensity, region of origin on the sun, association with visual phenomena, and polarization; on the basis of these characteristics a classification of types of solar noise is proposed. Known data on solar physics relevant to the generation and propagation of radio waves in the solar atmosphere are outlined, and the mode of origin is discussed. A thermal component whose intensity corresponds to black-body radiation of a temperature rising from 10^4 °K at a wavelength of 1 centimeter to 10^6 °K at a few meters, is recognized. This change is believed to be associated with a rise in the region of origin of the radiation from the lower chromosphere to the corona. Non-thermal components, prominent at meter wavelengths, are subject to remarkably rapid variations and reach occasional peak intensities 10^3 to 10^6 times the thermal ones. They are believed to originate in some form of electrical disturbance in the solar atmosphere. Discussion by M. Ryle, G. Millington, A. Hunter, H. Stanesby, E. C. Cherry, F. F. Roberts, and the author, is reported. (A; M.S.C.)

R-50-11 Reber, Grote. "Galactic Radio Waves," Astronomical Society of the Pacific Leaflet, No. 259 (Nov., 1950). 7 pages.

Jansky's discovery of galactic radio waves and the subsequent development of knowledge concerning them are briefly reviewed. (M.S.C.)

R-50-12 Ryle, Martin. "Radio Astronomy," Physics Today, 3. No. 2, 12-18 (Feb., 1950).

Developments in radio astronomy are reviewed, emphasis being placed on the interference technique of measurement and on the information which has resulted from its use. (M.S.C.)

R-50-13 Ryle, M. "Radio Astronomy," Reports on Progress in Physics, London, Physical Society, 13: 184-246 (1950).

The status of knowledge concerning radio astronomy is comprehensively reviewed. A discussion of the techniques and limitations of experimental investigations is followed by an account of the known observational data concerning solar and galactic radio waves. Previously unpublished results of certain experiments carried out at the Cavendish Laboratory are described. The report is concluded with a summary and analysis of the mechanisms which have been proposed in order to explain the observed phenomena. (M.S.C.)

R-50-14 Siedentopf, Heinrich. "Die Strahlung der Sonnenkorona im Wellenlangenbereich 1 cm bis 20 m (K-Bereich)" (Section of "Die Sonnenkorona"). Ergebnisse der Exakten Naturwissenschaften, Berlin,

Springer, 23, 33-45, and bibliography on pages 51-52, (1950).

Studies of solar radio emission are reviewed. Calculations, primarily by Unsöld (see B2-46-03 and A2-47-09) and by Waldmeier and Müller (see A2-48-14), concerning the radio-frequency radiation from the quiet sun are discussed. Observations of the radiation from the disturbed sun are described and suggestions regarding their theoretical interpretation are briefly summarized. (M.S.C.)

R-50-15 Struve, Otto. "Progress in Radio Astronomy - II," Sky and Telescope, 9, 55-56 (Jan., 1950).

A discussion of suggestions concerning the nature of radio stars is followed by a description of the interference method of observing them. (M.S.C.)

R-50-16 v. Klüber, Harald. "Die Sonnenkorona," Elektron in Wissenschaft und Technik, 4, 77-86 (Mar., 1950).

A section on "The Sun as a Radio Star" is included as part of a general descriptive review of present knowledge concerning the solar corona. (M.S.C.)

AUTHOR INDEX*

Alfvén, H.
with Herlofson G2-50-01

Allen, C. W. ..... (M-50-01)
with Gum B1-50-01
with Woolley A2-50-17

Australian National Committee of Radio Science, U. R. S. I. M-50-01

Bailey, V. A. A2-50-01, (M-50-01)
with Landecker A2-50-02

Beers, Y.
with Korff A2-50-07

Blum, E.-J.
with Denisse A1-50-01

Boehmer, H. W.
with Broxon M-50-02

Bolton, J. G. ..... (C1-50-02), (M-50-01)
with Westfold B1-50-02, B2-50-01, B2-50-02

Bracewell, R. N. A1-50-02, (A1-50-10)

British Astronomical Association A1-50-03, R-50-01

Brown, R. H.
with Hazard C1-50-01

Broxon, J. W.
with Boehmer M-50-02

Buneman, O. A2-50-03

Bureau, R. M-50-03
with Dauvillier A1-50-04

Cherry, E. C. ..... (R-50-10)

Christiansen, W. N. ..... (M-50-01)

Clarke, A. C. ..... (R-50-01)

Cotton, H. V. M-50-04

* For explanation see page 3.

AUTHOR INDEX

Covington, A. E. M-50-05

Crowley, D. J.
with Menzel C2-50-02

Dauvillier, A.
with Bureau A1-50-04

d'Azambuja, M. L. R-50-02

Denisse, J. F. A2-50-04, A2-50-05
with Blum A1-50-01

Elsmore, B.
with Ryle and Smith C1-50-04

Getmantsev, G. G.
with Ginsburg M-50-06

Ginsburg, V. L.
with Getmantsev M-50-06

Gum, C. S.
with Allen B1-50-01

Hagihara, Y. ..... (M-50-09)

Hall, J. S.
with Mikesell M-50-07

Hatanaka, T.
with Suzuki and Moriyama A1-50-05

Hazard, C.
with Brown C1-50-01

Herlofson, N.
with Alfvén C2-50-01

Hewish, A.
with Ryle C1-50-03

Hey, J. S. ..... (A1-50-10)

Hunter, A. ..... (R-50-10)

Institute of Radio Engineers R-50-03

AUTHOR INDEX

International Scientific Radio Union R-50-04

Jaeger, J. C.
with Westfold A2-50-06, (M-50-01)

Kiepenheuer, K. O. B2-50-03, B2-50-04

Korff, S. A.
with Beers A2-50-07

Kwal, B. A2-50-08

Labrum, N. R.
with Minnett A1-50-07

Laffineur, M.
with Michard, Servajean, and Steinberg A1-50-06

Landecker, K.
with Bailey A2-50-02

Little, C. G. ..... (C1-50-02)
with Lovell C1-50-05

Lovell, A. C. B. R-50-05
with Little C1-50-05

Malmfors, K. G. A2-50-09

McCready, L. L.
with Wild A1-50-16

Menzel, D. H.
with Crowley C2-50-02

Michard, R.
with Laffineur, Servajean, and Steinberg A1-50-06

Mikesell, A. H.
with Hall M-50-07

Millington, G. ..... (R-50-10)

Minnett, H. C.
with Labrum A1-50-07

Moriyama, F.
with Hatanaka and Suzuki A1-50-05

AUTHOR INDEX

Mullaly, R. F. ..... (M-50-01)

Muller, H.
with Waldmeier A2-50-15

Newton, H. W. ..... (A1-50-03), A1-50-08, (A1-50-10)

Nicolet, M. R-50-06

Öpik, E. R-50-07

Ovenden, M. W. A1-50-09, (R-50-01), R-50-08, R-50-09

Pawsey, J. L. ..... (M-50-01), (M-50-09), R-50-10

Payne-Scott, R. ..... (M-50-01)

Piddington, J. H. A2-50-10, (M-50-01)

Reber, G. R-50-11

Roberts, F. F. ..... (R-50-10)

Royal Astronomical Society A1-50-10, C1-50-02, M-50-09

Ryle, M. ..... (C1-50-02), (R-50-10), R-50-12, R-50-13
with Hewish C1-50-03
with Smith and Elsmore C1-50-04

Servajean, R.
with Laffineur, Michard, and Steinberg A1-50-06

Shklovsky, I. S. C2-50-03

Siedentopf, H. R-50-14

Slee, O. B.
with Stanley C1-50-06

Smerd, S. F. A2-50-11, A2-50-12, A2-50-13, (M-50-01)

Smith, F. G. C1-50-05
with Ryle and Elsmore C1-50-04

Smith-Rose, R. L. A1-50-11

Stanesby, H. ..... (R-50-10)

AUTHOR INDEX

Stanier, H. M. A1-50-12

Stanley, G. J.
with Slee C1-50-06

Steinberg, J.-L.
with Laffineur, Michard, and Servajean A1-50-06

Struve, O. R-50-15

Suzuki, S.
with Hatanaka and Moriyama A1-50-05

Twiss, R. Q. A2-50-14

van de Hulst, H. C. M-50-10

von Kluber, H. R-50-16

Waldmeier, M.
with Müller A2-50-15

Westfold, K. C. A2-50-16
with Bolton B1-50-02, B2-50-01, B2-50-02
with Jaeger A2-50-06, (M-50-01)

Wild, J. P. A1-50-14, A1-50-15, (M-50-01)
with McCready A1-50-16

Williamson, R. E. B2-50-05

Woolley, R. v. d. R. A1-50-17
with Allen A2-50-17

1 August 1952

Radio Astronomy Report No. 12 of the School of Electrical Engineering, Cornell University, is enclosed herewith. This report, which forms an extension to the "Bibliography of Extraterrestrial Radio Noise" (issued as Radio Astronomy Report No. 11 of the School of Electrical Engineering and as Part of the Report of Commission V to the IXth General Assembly of the International Scientific Radio Union), contains references and abstracts of appropriate publications issued during the year 1950 only. References and abstracts of pertinent papers which were published prior to 1950 but were not listed in the original "Bibliography of Extraterrestrial Radio Noise" will be distributed at a later date in the form of a brief addendum to Radio Astronomy Report No. 11.